CONTROL OF TRANSMISSION POWER IN WIRELESS PACKET DATA TRANSFER

BACKGROUND OF THE INVENTION

The present invention concerns in general control of transmission power in a cellular radio network and in particular it concerns a method for controlling the transmission power, taking the special features of the packet switched links into consideration.

Cellular networks based on radio communication have become the most general form of mobile bidirectional data transfer. Links between the terminal devices and base stations are most generally circuit switched, that is, a certain transfer capacity must be totally reserved for the use of a single active data transfer link, irrespective of whether the link in question requires continuous data transfer or not. In the GSM system (Global System for Mobile Communications) dealt with as an exemplified cellular system in this application, the data transfer capacity to be reserved for one link is one traffic channel formed by one TDMA time slot (Time Division Multiple Access) being cyclically repeated as well on the transmission fiequency as on the receiving frequency.

In the circuit switched data transfer one problem is formed by the sufficiency of the radio frequencies. If a certain circuit switched link requires actual data transfer only occasionally, the capacity reserved for it is for the rest of the time unnecessarily reserved. The problem is particularly clear in communications like the data calls. Data transfer in a packet form has been developed as a solution, whereby the data to be transferred is formed into separate packets that include the information on the receiver and can be transferred at unregular intervals. Between the packets the capacity used for transferring them can be addressed to be used by some other link.

For the control of the transmission power of the radio transmission, the data transfer in a packet form causes, however, problems that can't be solved by the methods known in connection with the circuit switched links. For clarifying the background of the present invention, the control of transmission power and the factors having influence on it in a known circuit switched cellular radio system are briefly described in the following.

The cellular system comprises central and controlling devices, base stations and terminal devices having radio interface with the base stations. It is preferable to set a certain power limit of the radio transmission for each base station and each terminal device. In a terminal device, the limiting of transmission power aims both at decreasing the interference to other radio links and to decreasing the power consumption of the device. Decisive factor for limiting the transmission power of the base station is the decreasing of inteiference. It is profitable to limit the transmission power of the transmitting radio device as small as possible, but in such a way, however, that the receiving device is able to receive the transmission without considerable errors and distortions caused by noise and interference. The limiting of power is closely connected to maintaining the quality of the radio link and different parameters indicating the quality of the received signal are generally used in it. Requirements set for the quality of the link can vary depending on what kind of information it has to be transferred in the link.

The control of the transmission power can be based on open-loop or closed-loop. In the open-loop control, where the data transfer is bidirectional, the transmitting device doesn't get any information on the quality of the arrived

signal as feedback, but it makes the decision on changing the transmission power by measuring the level of the signal it has received. The workability of the method is based on the fact that the transmission and receiving frequencies are the same, whereby the path attenuation in both directions is the same or so close to one another that the path attenuations at least strongly correlate. In the closed-loop control the receiving device measures the quality of the signal that it has received and delivers a parameter describing it back to the transmitting device. The closed-loop control is a reliable method, but the receiving of the signal, the processing of the parameters that describe the quality, and the transmission of the information back to the transmitting device take time. Additionally, the closed-loop control increases the signaling effort required for the radio link.

Factors that are in connection with the power control and caused by the signal attenuation can be classified to slow and fast ones. The slow fading is caused by the changing distance between the terminal device and the base station or by roaming of the terminal device to dead spaces caused by some object or by some terrain form preventing the radio wave propagation. These factors also have influence on the uplink and downlink radio connection in the same way, and the respective time scale is of the range of several seconds. The fast fading is caused by the fact that a destructive interference of waves propagating on different paths occurs by the radio receiver, and it happens typically in less than a second. Also, the influence of the fast fading on the uplink and downlink radio connections does not correlate.

In the known closed-loop control method applied to e.g. in the GSM system, the received signal level must be measured at least during half a second, after which the delivery of the result, that is, the measuring report, uplink from the terminal device to the base station controller, takes about half a second. The base station controller typically averages the received measuring reports for about two seconds and it takes half a second again to deliver the received result to the terminal device. So, the cumulative delay will be several seconds.

In packet data transmission the radio channel is reserved for a certain transmission for about 50 ms through 5 s at a time. The closed-loop control method described above is not applicable to that kind of radio transmission, because the transmitting device has no time to receive any control message at all before the transmission is ended. Even in those cases where the control message arrives in time, the portion of the transmission with wrong power is as to the time unreasonably big.

For a man skilled in the art it is clear that it is possible to try to speed up the closed-loop control described above, by decreasing delays in a way known in the art. In addition, the averaging can be moved from the receiving device to the transmitting device, whereby, however, the need for signaling will be increased and the transmitting device made more complicated. Known from the patent publication U.S. Pat. No. 5,465,398 there is a method, wherein the receiver of a wireless local network measures the signal power from every packet received successfully, and compares it with the minimum power value it has in store, by which the receiving of the packet will be successful. The receiver sends to the transmitting device information about the difference between the received signal power and the minimum power. The transmitting device calculates a moving average from the received differences and adjusts its transmission power so that the mean value of the differences gets closer to a certain predetermined limit value.

The power control method proposed by the publication is, however, mainly applicable to continuous transmission or to